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Klaus Kunze

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EXAMINER

TRINH, MICHAEL MANH

ART UNIT

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2822

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PAPER

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

<b>Office Action Summary</b>	<b>Application No.</b> 10/616,147	<b>Applicant(s)</b> KUNZE ET AL.	
	<b>Examiner</b> Michael Trinh	<b>Art Unit</b> 2822	

**-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --**

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 23 November 2009.
- 2a) ☒ This action is **FINAL**.                      2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) See Continuation Sheet is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 41, 44, 46, 51, 53-54, 58-59, 61-65, 100-101, 103-119, 121-125, 128, 136-147, 149-150, 152, 155-165, 204, 206, 231, and 235 is/are allowed.
- 6) ☒ Claim(s) See Continuation Sheet is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |                                                                                      |                                                                   |
|--------------------------------------------------------------------------------------|-------------------------------------------------------------------|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)          | 4) <input type="checkbox"/> Interview Summary (PTO-413)           |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____                                      |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08)          | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date _____                                                          | 6) <input type="checkbox"/> Other: _____                          |

Continuation of Disposition of Claims: Claims pending in the application are 41,44,46,51,53,54,57-59,61-65,100,101,103-119,121-128,131,136-147,149-150,152-165,168-173,175-184,189,192-197,199-201 and 204-235.

Continuation of Disposition of Claims: Claims rejected are 57,126,127,131,153,154,168-173,175-184,189,192-197, 199-201,205,207-230 and 232-234.

## DETAILED ACTION

\*\*\* This office action is responsive to Applicant's amendment filed November 23, 2009. Claims 41,44,46,51,53-54,57-59,61-65,100-101,103-119,121-128,131,136-147, 149-150,152-165,168-173,175-184,189,192-197,199-201, and 204-235 are pending, in which claims 206-235 have been newly added.

\*\*\* The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

### *Election/Restrictions*

1. Applicant's Amendment and remarks filed November 23, 2009, together with the Declaration under 37 C.F.R. 1.132 of Fabio Zurcher filed November 23, 2009, have overcome the rejection of generic base claim 41.

Independent claim 41 is allowed below. Upon the allowance of a generic base claim, applicant will be entitled to consideration of claims to *additional species which are written in dependent form or otherwise include all the limitations of an allowed generic claim as provided by 37 CFR 1.141*. Accordingly, the restriction requirement of record is hereby withdrawn. All claims are considered and examined for patentability. In view of the withdrawal of the restriction requirement, applicant(s) are advised any claim(s) in a continuation or divisional application may be subject to provisional statutory and/or nonstatutory double patenting rejections over the claims of the instant application. Once the restriction requirement is withdrawn, the provisions of 35 U.S.C. 121 are no longer applicable. See *In re Ziegler*, 44 F.2d 1211, 1215, 170 USPQ 129, 131-32 (CCPA 1971). See also MPEP § 804.01.

### *Claim Rejections - 35 USC § 103*

2. Claims 207-210,57,126-127,131,153,154,169-173,178-184,189,194-197,232 are rejected under 35 U.S.C. 103(a) as being unpatentable over Shiho et al (2003/0045632) taken with Jacobson et al (6,294,401).

Re base claim 207, Shiho teaches (at paragraphs 38-93) a method for making a patterned semiconductor film comprising at least the steps of: printing (paragraphs 110, 153,54-64,162-167) a solution composition comprising semiconductor nanoparticles, a first cyclic Group IVA

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compound of the formula  $\text{Si}_n\text{R}_m$ ,  $n$  is an integer of 3 or more and  $m$  is integer of  $2n+2$ , wherein  $\text{Si}_n\text{H}_{2n+2}$  ( $n$  is of 2 to 8), or  $\text{Si}_i\text{H}_{2j}$  ( $j$  is of 2 to 8) or  $\text{Si}_k\text{H}_k$  ( $k$  is 6,8, or 10) are mentioned at paragraphs 18,44 (Re also claims 178-179), which formula of Shiho reads on the claimed formula of  $(\text{AH}_x)_n$ , with  $A$  is Si,  $n$  is 3 to 8, and  $x$  is 1 or 2; and a cycloalkane solvent including cyclohexane (as one of cyclolalkanes) (paragraphs 0103,0102,153) in a pattern/film on a substrate, wherein by the application of the liquid material the patterning may be carried out at the same time by the ink jet method (paragraph 153); and b) curing said printed pattern/film to form said patterned semiconductor film (paragraphs 117,120,127,137,138). Re claim 208, wherein  $A$  is Si (paragraphs 40-93). Re claim 209, wherein the formula is  $\text{Si}_n\text{R}_m$ ,  $n$  is an integer of 3 or more and  $m$  is integer of  $2n+2$ , wherein  $\text{Si}_n\text{H}_{2n+2}$  ( $n$  is of 2 to 8), or  $\text{Si}_i\text{H}_{2j}$  ( $j$  is of 2 to 8) or  $\text{Si}_k\text{H}_k$  ( $k$  is 6,8, or 10) are mentioned at paragraphs 18,44, wherein dopants of B, P, and As with at least alkyl group are mentioned at paragraphs 76-82, which is corresponding to claimed formula (1): $(\text{AH}_x)_n$ , where  $n$  is from 3 to 8 and each  $A$  in the formula is independently Si, and/or a second cyclic Group IVA compound of the formula (2): $(\text{AH}_x)_m(\text{AH}_y\text{R}_z)_p(\text{ZR}')_q$ , (2) where  $(m+p+q)$  is from 3 to 12, each of the  $m$  instances of  $x$  is independently 0, 1 or 2, each of the  $p$  instances of  $y$  is independently 0, 1 or 2, each of the  $p$  instances of  $z$  is independently 0, 1 or 2, each of the  $p$  instances of  $(y+z)$  is independently 1 or 2, each of the  $q$  instances of  $w$  is independently 0 or 1, at least one of  $p$  and  $q$  is at least 1, each  $A$  in the formula (2) is independently Si,  $Z$  is selected from the group consisting of B, P and As,  $R'$  is R or H, and each R in the formula (2) is independently alkyl, aryl, aralkyl, a halogen,  $\text{BHsR}''^{2s}$ ,  $\text{PHsR}''^{2-s}$ ,  $\text{AsHR}''^{2-s}$  or  $\text{AHtR}''^{.sub.3-t}$ , where  $s$  is 0 to 2,  $t$  is 0 to 3, and  $R''$  is alkyl, aryl, aralkyl, a halogen, or  $\text{AH}_3$  (Re also claims 180-182). Re claims 210,183,194,195, wherein the cyclic compounds are present in the solution of from 0.1 to 100 wt% (paragraphs 56-57,47,86), and wherein the amount of silicon nanoparticles is about 0.1 to 100 wt% (paragraphs 62-63). Re claim 57, wherein the printing step of the solution into the pattern onto the substrate at least comprises inkjet printing, offset printing, and screen printing (paragraph 0110). Re claims 126-127, wherein curing by heating so as to sintering the printed patterned so as to dry the printed patterned at a temperature at least about  $200^\circ\text{C}$  (paragraphs 117,120,137-138), wherein sintering temperature is at least about  $300^\circ\text{C}$  (paragraphs 117,120,137-138). Re claims 131,153,154, wherein curing the printed pattern by irradiating (paragraphs 138,113,137,120,153) the printed

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pattern with a light to cure it, and to polymerize the irradiated portions, thereby render it insoluble polymer, inherently, and thereby resist subsequent treatment with processing solvent. Re claim 232, wherein the printing step is conducted in a non-oxidizing atmosphere, such as, nitrogen or rare gas, which is an inert gas (paragraphs 0111,0110). Re claim 169, wherein removing the solvent from the printed solution by evaporating the solvent prior to heat and/or light treating to curing (paragraph 0102,0110). Re claims 170-172, wherein curing by heating so as to sintering the pattern as the semiconductor film so as to dry the semiconductor film at a temperature at least about 200°C (paragraphs 117,120,137-138), wherein sintering temperature is at least about 300°C (paragraphs 117,120,137-138). Re claim 173, wherein the semiconductor nanoparticles consist essentially of silicon nanoparticles (at paragraphs 60-64). Re claim 184, wherein the solution consists essentially of the semiconductor nanoparticles, the first cyclic Group IVA compound and the solvent (at paragraphs 103, 60-64,110, 38-93). Re claim 189, wherein the cycloalkane solvent, such as cyclohexane (mentioned at paragraph 0103) is one of C<sub>5</sub>-C<sub>12</sub> cycloalkanes. Re claims 196,197, wherein the substrate comprising a glass or plastic window with two dimensional array of fields thereon for production of an array of solar cells (paragraphs 133,148-151).

As applied above, Shiho already teaches a solution having semiconductor nanoparticles and a cycloalkane solvent including cyclohexane as one of cyclolalkanes.

Re claim 207, Shiho thus does not mention *passivated* semiconductor nanoparticles.

However, Jacobson '401 prima facie teaches (at col 5, lines 34-60; col 3, lines 36-65; col 4, lines 32-64) inkjet printing, screen printing, or gravure printing a solution comprising *passivated* semiconductor nanoparticles (col 4, lines 47-67) having a capping passivation layer in order to form a pattern (col 5, lines 34-45, col 6, lines 1-10; col 4, lines 13-15; Fig 4, col 7, lines 10-20), wherein the nanoparticles may be passivated at the surface by an organic capping group which is largely determined the solubility of the nanoparticles including silicon (col 4, lines 48-64).

Therefore, the subject matter as a whole would have been obvious to one of ordinary skill in the art at the time the invention was made to print a solution comprising semiconductor nanoparticles to form the semiconductor pattern of Shiho by employing the passivated

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semiconductor nanoparticles, as taught by Jacobson et al '401. This is because of the desirability to be able to determine the solubility of the nanoparticles in an appropriate solvent for carrying the nanoparticles in an effective manner, thereby enable to print highly ordered semiconductor thin film onto a substrate. This is also because of the desirability to employing the passivation layer as a capping layer to protect and retard growing of the silicon nanoparticles, thereby effectively controlling size of semiconductor nanoparticles. Moreover, it would have been obvious because a person of ordinary skill in the art would have been motivated to combine the prior art to achieve the claimed invention and that there would have been a reasonable expectation of success when employing a composition solution in printing methods of ink jet printing, gravure printing, printing by offset lithography, flexographic printing, as well known in the art, because "a person of ordinary skill has a good reason to pursue the known options within his or her technical grasp. If this lead to the anticipated success, it is likely the product not of innovation but of ordinary skill and common sense" for forming a plurality of semiconductor patterns on a substrate, and because these printing methods as particular known techniques were recognized as part of the ordinary capabilities. In re Supreme Court Decision in KSR International Co. v. Teleflex Inc. 82 USPQ2d, 1385 (2007). The subject matter as a whole would have been obvious to one of ordinary skill in the art at the time the invention was made to select the portion of the prior art's range of value for x and n in the formula, percentage by weight, and prior art's range of temperature, as taught by Shiho and Jacobson '401, which is within the range of applicant's claims, because it has been held to be obvious to select a value in a known range by optimization for the best results, and would be an unpatentable modification, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation". *In Re Aller* 104 USPQ 233,255 (CCPA 1955); *In re Waite* 77 USPQ 586 (CCPA 1948); *In Re Swanson* 56 USPQ 372 (CCPA 1942); *In Re Sola* 25 USPQ 433 (CCPA 1935); and *In Re Dreyfus* 24 USPQ 52 (CCPA 1934).

3. Claims 168,205 are rejected under 35 U.S.C. 103(a) as being unpatentable over Shiho et al (2003/0045632) and Jacobson et al (6,294,401), as applied to claims 207-210,57,126-127,131,153,154,169-173,178-184,189,194-197,232 above, and further of Tani et al (5,254,439).

The references including Shiho and Jacobson teach a method for making a semiconductor film as applied to claims 207-210,57,126-127,131,153,154,169-173,178-184,189,194-197,232 . Shiho also teaches (at paragraphs 127,110-113). Shiho also teaches (at paragraph 110) printing the composition to form the pattern and irradiating the composition with an ultraviolet light (paragraph 138), wherein when the coating film is to be treated with light to convert it into a silicon film, the desired pattern can also be formed by exposing part of the coating film selectively using a photomask having a desired pattern (paragraph 127).

The references including Shiho thus lack selectively irradiating the composition before curing.

However, Tani teaches (at Figs 2,3; col 5, line 60 through col 6) selectively irradiating the layer through a mask aligned on substrate as marked, and removing a portion of the layer after irradiating in order to form a plurality of patterned layers.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to pattern the semiconductor film of the references including Shiho and Jacobson '401 by selectively irradiating through a mask and removing a portion of the layer as taught by Tani before curing the semiconductor film of Shiho. This is because these patterning techniques are alternative and art recognized equivalent for substitution in forming distinct patterned semiconductor films on the substrate so as a plurality of semiconductor thin film transistors can be fabricated at the same time.

4. Claims 176-177,192-193,234 are rejected under 35 U.S.C. 103(a) as being unpatentable over Shiho et al (2003/0045632) and Jacobson et al (6,294,401), as applied to claims 207-210,57,126-127,131,153,154,169-173,178-184,189,194-197,232 above, and further of Korgel (2003/0034486).

The references including Shiho and Jacobson teach a method for making a semiconductor film as applied to claims 207-210,57,126-127,131,153,154,169-173,178-184,189,194-197,232 .

Re claims 176-177,192-193, Shiho already teaches (at paragraphs 0061-0062) forming silicon particles having a diameter of from 0.005 micron (5 nm as 1 micron equals to 1000nm),



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while claims 176-177, 192-193 recite silicon particles having an average diameter of less than 5 nm or 3.5 nm.

However, Korgel teaches (at col 15, lines 12-30) forming silicon particles comprising nano-particles having an average diameter of about 5 nm, 3.5 nm, or 2 nm. Jacobson '401 teaches (at col 6, lines 40-43; col 4, lines 25-30, lines 44-46) forming nanoparticles having a size below 2.5 nm.

The subject matter as a whole would have been obvious to one of ordinary skill in the art at the time the invention was made to select the portion of the prior art's range of average diameter of silicon particles, as taught by Korgel and Jacobson, which is within the range of applicant's claims, because of the desirability to form silicon nanoparticles for forming very small devices, and because it has been held to be obvious to select a value in a known range by optimization for the best results, and would be an unpatentable modification, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation". *In Re Aller* 104 USPQ 233,255 (CCPA 1955); *In re Waite* 77 USPQ 586 (CCPA 1948); *In Re Swanson* 56 USPQ 372 (CCPA 1942); *In Re Sola* 25 USPQ 433 (CCPA 1935); and *In Re Dreyfus* 24 USPQ 52 (CCPA 1934).

Re claim 234, the references including Shiho and Jacobson already teaches passivated semiconductor nanoparticles, while claim 234 recites further comprising a dopant.

However, Korgel further teaches doping of the semiconductor nanoparticles with a dopant (paragraphs 121-126).

Therefore, the subject matter as a whole would have been obvious to one of ordinary skill in the art at the time the invention was made to employing the passivated silicon nanoparticles of the references of Jacobson and Shiho by doping the semiconductor nanoparticles with the dopant, as taught by Korgel. This is because of the desirability to introduce a conductivity type into the semiconductor nanoparticles, and to increase the electrical conductivity of the semiconductor nanoparticles.

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5. Claim 175 is rejected under 35 U.S.C. 103(a) as being unpatentable over Shiho et al (2003/0045632) and Jacobson et al (6,294,401), as applied to claims 207-210,57,126-127,131,153,154,169-173,178-184,189,194-197,232, and further of Nayfeh et al (6,585,947).

The references including Shiho and Jacobson teach a method for making a semiconductor film as applied to claims 207-210,57,126-127,131,153,154,169-173,178-184,189,194-197,232, wherein Shiho also teaches employing the printed semiconductor nanoparticle film for forming electronic devices, and wherein Jacobson teaches printing a solution comprising passivated semiconductor nanoparticles (col 4, lines 47-67) having a capping passivation layer in order to form a pattern (col 5, lines 34-45, col 6, lines 1-10; col 4, lines 13-15; Fig 4, col 7, lines 10-20), wherein the nanoparticles may be passivated at the surface by an organic capping group which is largely determined the solubility of the nanoparticles including silicon (col 4, lines 48-64).

The references including Shiho and Jacobson already teach printing a solution comprising passivated semiconductor nanoparticles, while claim 175 recites the passivation layer comprising of, such as, hydrogen.

However, Nayfeh teaches a solution comprising passivated semiconductor nanoparticles, wherein the passivation layer comprises hydrogen (col 5, lines 3-12; col 3, lines 35 to col 6).

Therefore, the subject matter as a whole would have been obvious to one of ordinary skill in the art at the time the invention was made to print a solution having the passivated semiconductor nanoparticles for forming the patterned semiconductor film of the references including Jacobson and Shiho by employing the passivated semiconductor nanoparticles with the passivation layer comprising of high quality hydrogen coating, as taught by Nayfeh. This is at least because the high quality coating fully protects the semiconductor nanoparticles from uncontrollable low quality post interactions in the ambient atmosphere.

6. Claims 199-201 are rejected under 35 U.S.C. 103(a) as being unpatentable over Shiho et al (2003/0045632) and Jacobson et al (6,294,401), as applied to claims 207-210,57,126-127,131,153,154,169-173,178-184,189,194-197,232 above, and further of Griffith et al (6,348,295) and Maloney et al (2002/0076495).

The references including Shiho and Jacobson teach a method for making a semiconductor film as applied to claims 207-210,57,126-127,131,153,154,169-173,178-184,189,194-197,232, wherein Shiho also teaches employing the printed semiconductor nanoparticle film for forming electronic devices, wherein a desired pattern can be formed by photomasking or lithography (paragraphs 153,127).

The references including Shiho lacks performing a solvent cleaning as recited in claims 199-201.

However, Griffith teaches (at col 5, lines 3-45,46-67; cols 1-5) performing a solvent washing to clean the substrate having the patterned semiconductor film printed thereon. Maloney teaches (at paragraphs 202,201,97141-144,148-150; Figs 1-5; paragraphs 85 to 205) performing a rinsing with the same solvent used in the solution to wash off and to clean the substrate having the patterned film thereon.

The subject matter as a whole would have been obvious to one of ordinary skill in the art at the time the invention was made to form the semiconductor device of the references including Shiho by performing a solvent washing to clean the substrate having the patterned semiconductor film printed thereon, by rinsing with the same solvent used in the solution, as taught by Griffith and Maloney, wherein draining and drying after rinsing are inherent in order to remove the solvent from the substrate and also as well known in the art. This is because of the desirability to cleaning the substrate and patterned film thereon.

7. Claims 226-230 are rejected under 35 U.S.C. 103(a) as being unpatentable over Shiho et al (2003/0045632) and Jacobson et al (6,294,401), as applied to claims 207-210,57,126-127,131,153,154,169-173,178-184,189,194-197,232 above, and further of Kim et al (6,355,198) and Komyoji (2002/0050061).

The references including Shiho and Jacobson teach a method for making a semiconductor film as applied to claims 207-210,57,126-127,131,153,154,169-173,178-184,189,194-197,232 .

Shiho already teaches inkjet printing a semiconductor film having a thickness, particularly preferably of 0.01 to 5 $\mu$ m (paragraph 0110), while claims 226-230 recite the pattern

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comprises lines having a width of from 0.5 to 50 $\mu$ m, spacing from 100nm to 100  $\mu$ m, a length of from 2 to 2000 $\mu$ m, and a thickness of from 0.01 to 500  $\mu$ m.

However, Kim teaches (at Figs 1,15,16; col 34, lines 13-50) printing and curing a composition to form a plurality of lines having a typical width of from 1 $\mu$ m to 10 $\mu$ m, a length of from 100 $\mu$ m, a thickness which is similar to the width, and the spacing of from 1 $\mu$ m to 10 $\mu$ m. Komyoji teaches (at Figs 11,12,13-14,47-49; paragraphs 231-239; 163-239) printing to form a pattern comprising one or more lines having a width of about 80 micron (e.g. paragraph 231), a thickness of about 6 micron, and a pitch of spacing of about 200 micron.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the semiconductor film of the references including Shiho and Jacobson as the pattern comprising lines of a patterned semiconductor film having a typical width of from 1 $\mu$ m to 10 $\mu$ m, a length of from 100 $\mu$ m, and a thickness as similar to a width of from 1 $\mu$ m to 10 $\mu$ m by inkjet printing, gravure printing, offset printing, as taught by Kim, Komyoji, Jacobson, and Shiho above. This is because of the desirability to form a plurality of lines of semiconductor patterns having a desired and predetermined dimensions on the substrate as to manufacture a plurality of semiconductor devices. The subject matter as a whole would have been also obvious to one of ordinary skill in the art at the time the invention was made to select the portion of the prior art's range of thickness, width, spacing, length, as taught by Kim and Shiho, which is within the range of applicant's claims, because it has been held to be obvious to select a value in a known range by optimization for the best results, and would be an unpatentable modification, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation". *In Re Aller* 104 USPQ 233,255 (CCPA 1955); *In re Waite* 77 USPQ 586 (CCPA 1948); *In Re Swanson* 56 USPQ 372 (CCPA 1942); *In Re Sola* 25 USPQ 433 (CCPA 1935); and *In Re Dreyfus* 24 USPQ 52 (CCPA 1934).

8. Claims 211-213,217-223,225,231,233 are rejected under 35 U.S.C. 103(a) as being unpatentable over Shiho et al (2003/0045632) taken with Jacobson et al (6,294,401), Kim et al (6,355,198), and Komyoji (2002/0050061).

Re base claim 211, Shiho teaches (at paragraphs 38-93) a method for making a patterned semiconductor film comprising at least the steps of: printing (paragraphs 110, 153, 54-64, 162-167) a solution composition comprising semiconductor nanoparticles, a first cyclic Group IVA compound of the formula  $\text{Si}_n\text{R}_m$ ,  $n$  is an integer of 3 or more and  $m$  is integer of  $2n+2$ , wherein  $\text{Si}_n\text{H}_{2n+2}$  ( $n$  is of 2 to 8), or  $\text{Si}_i\text{H}_{2j}$  ( $j$  is of 2 to 8) or  $\text{Si}_k\text{H}_k$  ( $k$  is 6, 8, or 10) are mentioned at paragraphs 18, 44 (Re also claims 218, 219), which formula of Shiho reads on the claimed formula of  $(\text{AH}_x)_n$ , with  $A$  is Si,  $n$  is 3 to 8, and  $x$  is 1 or 2; and a solvent (paragraphs 0103, 0102, 153) to form a pattern/film on a substrate, wherein by the application of the liquid material the patterning may be carried out at the same time by the ink jet method (paragraph 153); and b) curing said printed pattern/film to form said patterned semiconductor film (paragraphs 117, 120, 127, 137, 138), wherein Shiho also teaches inkjet printing a pattern of semiconductor film having a thickness, preferably of 0.01 to  $5\mu\text{m}$  (paragraph 0110). Re claim 217, wherein  $A$  is Si (paragraphs 40-93). Re claim 220, wherein the cyclic compounds are present in the solution of from 0.1 to 100 wt% (paragraphs 56-57, 47, 86), and wherein the amount of silicon nanoparticles is about 0.1 to 100 wt% (paragraphs 62-63). Re claim 225, wherein the printing step of the solution into the pattern onto the substrate at least comprises inkjet printing, offset printing, and screen printing (paragraph 0110). Re claim 212, wherein curing by heating so as to sintering the printed patterned so as to dry the printed patterned at a temperature at least about  $200^\circ\text{C}$  (paragraphs 117, 120, 137-138), wherein sintering temperature is at least about  $300^\circ\text{C}$  (paragraphs 117, 120, 137-138). Re claim 213, wherein the semiconductor nanoparticles consist essentially of silicon nanoparticles (at paragraphs 60-64). Re claim 221, wherein the solution consists essentially of the semiconductor nanoparticles, the first cyclic Group IVA compound and the solvent (at paragraphs 103, 60-64, 110, 38-93). Re claim 222, wherein the substrate comprising a glass or plastic window with two dimensional array of fields thereon for production of an array of solar cells (paragraphs 133, 148-151). Re claim 223, wherein removing the solvent from the printed solution by evaporating the solvent prior to heat and/or light treating to curing (paragraph 0102, 0110). Re claim 233, wherein the printing step is conducted in a non-oxidizing atmosphere, such as, nitrogen or rare gas, which is an inert gas (paragraphs 0111, 0110). Re claim 231, wherein the printing step is conducted in a non-oxidizing atmosphere, such as, nitrogen or rare gas, which is an inert gas (paragraphs 0111, 0110).

As applied above, re claim 211, Shiho already teaches printing a solution having semiconductor nanoparticles to form a pattern having a having a thickness of about 0.01 to 5 $\mu$ m (re also claim 211 and 229).

Re claim 211, Shiho thus does not mention *passivated* semiconductor nanoparticles, and lacks detailing about other dimensions (length, width, spacing) of one or more lines of the pattern.

However, Jacobson '401 prima facie teaches (at col 5, lines 34-60; col 3, lines 36-65; col 4, lines 32-64) inkjet printing, screen printing, or gravure printing a solution comprising *passivated* semiconductor nanoparticles (col 4, lines 47-67) having a capping passivation layer in order to form a pattern (col 5, lines 34-45, col 6, lines 1-10; col 4, lines 13-15; Fig 4, col 7, lines 10-20), wherein the nanoparticles may be passivated at the surface by an organic capping group which is largely determined the solubility of the nanoparticles including silicon (col 4, lines 48-64). Kim teaches (at Figs 1,15,16; col 34, lines 13-50) printing and curing a composition to form a plurality of lines having a typical width of from 1 $\mu$ m to 10 $\mu$ m, a length of from 100 $\mu$ m, and a thickness which is similar to the width, and a spacing of from 1 $\mu$ m to 10 $\mu$ m. Komyoji teaches (at Figs 11,12,13-14,47-49; paragraphs 231-239; 163-239) printing to form a pattern comprising one or more lines having a width of about 80 micron (e.g. paragraph 231), a thickness of about 6 micron, and a pitch of spacing of about 200 micron.

Therefore, the subject matter as a whole would have been obvious to one of ordinary skill in the art at the time the invention was made to print a solution comprising semiconductor nanoparticles to form the semiconductor pattern of Shiho by employing the passivated semiconductor nanoparticles, as taught by Jacobson et al '401. This is because of the desirability to able to determine the solubility of the nanoparticles in an appropriate solvent for carrying the nanoparticles in an effective manner, thereby enable to print highly ordered semiconductor thin film onto a substrate. This is also because of the desirability to employing the passivation layer as a capping layer to protect and retard growing of the silicon nanoparticles, thereby effectively controlling size of semiconductor nanoparticles. Moreover, it would have been obvious because a person of ordinary skill in the art would have been motivated to combine the prior art to

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achieve the claimed invention and that there would have been a reasonable expectation of success when employing a composition solution in printing methods of ink jet printing, gravure printing, printing by offset lithography, flexographic printing, as well known in the art, because “a person of ordinary skill has a good reason to pursue the known options within his or her technical grasp. If this lead to the anticipated success, it is likely the product not of innovation but of ordinary skill and common sense” for forming a plurality of semiconductor patterns on a substrate, and because these printing methods as particular known techniques were recognized as part of the ordinary capabilities. In re Supreme Court Decision in KSR International Co. v. Teleflex Inc. 82 USPQ2d, 1385 (2007). The subject matter as a whole would have been obvious to one of ordinary skill in the art at the time the invention was made to select the portion of the prior art's range of value for x and n in the formula, percentage by weight, and prior art's range of temperature, as taught by Shiho and Jacobson '401, which is within the range of applicant's claims, because it has been held to be obvious to select a value in a known range by optimization for the best results, and would be an unpatentable modification, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation”. *In Re Aller* 104 USPQ 233,255 (CCPA 1955); *In re Waite* 77 USPQ 586 (CCPA 1948); *In Re Swanson* 56 USPQ 372 (CCPA 1942); *In Re Sola* 25 USPQ 433 (CCPA 1935); and *In Re Dreyfus* 24 USPQ 52 (CCPA 1934).

Re further claim 211, Shiho already teaches printing to form the pattern having a thickness preferably of 0.01 to 5 $\mu$ m (paragraph 0110), while claims 211 recite the pattern comprises one or more lines having thickness not more than 1000  $\mu$ m (0.01 to 500  $\mu$ m in claim 229), a width of not more than 100  $\mu$ m (0.5 to 50 $\mu$ m in claim 226), a length of not more than 5000 $\mu$ m (2 to 2000 $\mu$ m in claim 228), and a spacing not more than 100  $\mu$ m (100nm to 100  $\mu$ m in claim 227).

However, Kim teaches (at Figs 1,15,16; col 34, lines 13-50) printing and curing a composition to form a plurality of lines having a typical width of from 1 $\mu$ m to 10 $\mu$ m, a length of from 100 $\mu$ m, a thickness which is similar to the width, and the spacing of from 1 $\mu$ m to 10 $\mu$ m. Jacobson also teaches printing to form a pattern comprising one or more patterned conductor lines 510,511,512 (Fig 5, col 7, lines 30-47; col 5, line 34-51), wherein nanoparticle conductors

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are printed on a substrate to form a spiral pattern comprising one or more lines (Fig 4; col 7, lines 10-30). Komyoji teaches (at Figs 11,12,13-14,47-49; paragraphs 231-239; 163-239) printing to form a pattern comprising one or more lines having a width of about 80 micron (e.g. paragraph 231), a thickness of about 6 micron, and a pitch of spacing of about 200 micron.

Therefore, the subject matter as a whole would have been obvious to one of ordinary skill in the art at the time the invention was made to form the semiconductor film of the references including Shiho and Jacobson as the pattern comprising one or more lines of a patterned semiconductor film having the typical width of from 1 $\mu$ m to 10 $\mu$ m, the length of from 100 $\mu$ m, and the thickness as similar to the width of from 1 $\mu$ m to 10 $\mu$ m by inkjet printing, gravure printing, offset printing, as taught by Kim, Komyoji, Shiho, and Jacobson above. This is because of the desirability to form a plurality of lines of semiconductor patterns having a desired and predetermined dimensions on the substrate as to manufacture a plurality of semiconductor devices. The subject matter as a whole would have been also obvious to one of ordinary skill in the art at the time the invention was made to select the portion of the prior art's range of thickness, width, spacing, length, as taught by Kim, Komyoji, and Shiho, which is within the range of applicant's claim 211 of having a width of not more than 100  $\mu$ m ( 0.5 to 50 $\mu$ m in claim 226), a length of not more than 5000 $\mu$ m (2 to 2000 $\mu$ m in claim 228), a thickness of not more than 1000 $\mu$ m (0.01 to 500  $\mu$ m in claim 229), and a spacing not more than 100  $\mu$ m (100nm to 100  $\mu$ m in claim 227), because it has been held to be obvious to select a value in a known range by optimization for the best results, and would be an unpatentable modification, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation". *In Re Aller* 104 USPQ 233,255 (CCPA 1955); *In re Waite* 77 USPQ 586 (CCPA 1948); *In Re Swanson* 56 USPQ 372 (CCPA 1942); *In Re Sola* 25 USPQ 433 (CCPA 1935); and *In Re Dreyfus* 24 USPQ 52 (CCPA 1934).

9. Claims 215,216,235 are rejected under 35 U.S.C. 103(a) as being unpatentable over Shiho (2003/0045632), Jacobson (6,294,401), Kim (6,355,198), Komyoji (2002/0050061), as applied to claims 211-213,217-223,225,233 above, and further of Korgel (2003/0034486).



The references including Shiho, Jacobson, Kim, Komyoji teach a method for making a pattern of semiconductor film, as applied to claims 211-213, 217-223, 225, 233 above.

Re claims 215-216, Shiho already teaches (at paragraphs 0061-0062) forming silicon particles having a diameter of from 0.005 micron (i.e. 5 nm), while claims 215-216 recite an average particle diameter of less than 5 nm (claim 215), and a particle size distribution of 0.2 nm to less than 10nm.

However, Korgel further teaches (at col 15, lines 12-30) forming silicon particles comprising nano-particles having an average diameter of about 5 nm, 3.5 nm, or 2 nm. Jacobson '401 teaches (at col 6, lines 40-43; col 4, lines 25-30, lines 44-46) forming nanoparticles having a size below 2.5 nm.

The subject matter as a whole would have been obvious to one of ordinary skill in the art at the time the invention was made to select the portion of the prior art's range of average diameter of silicon particles, as taught by Korgel and Jacobson, and Shiho, which is within the range of applicant's claims, because of the desirability to form silicon nanoparticles for forming very small devices, and because it has been held to be obvious to select a value in a known range by optimization for the best results, and would be an unpatentable modification, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation". *In Re Aller* 104 USPQ 233,255 (CCPA 1955); *In re Waite* 77 USPQ 586 (CCPA 1948); *In Re Swanson* 56 USPQ 372 (CCPA 1942); *In Re Sola* 25 USPQ 433 (CCPA 1935); and *In Re Dreyfus* 24 USPQ 52 (CCPA 1934).

Re claim 235, the references including Shiho and Jacobson already teaches passivated semiconductor nanoparticles, while claim 235 recites further comprising a dopant.

However, Korgel further teaches doping of the semiconductor nanoparticles with a dopant (paragraphs 121-126).

Therefore, the subject matter as a whole would have been obvious to one of ordinary skill in the art at the time the invention was made to employing the passivated silicon nanoparticles of the references including Jacobson, Shiho, Kim by doping the semiconductor nanoparticles with the dopant, as taught by Korgel. This is because of the desirability to introduce a conductivity

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type into the semiconductor nanoparticles, and to increase the electrical conductivity of the semiconductor nanoparticles.

10. Claim 214 is rejected under 35 U.S.C. 103(a) as being unpatentable over Shiho (2003/0045632), Jacobson (6,294,401), Kim (6,355,198), Komyoji (2002/0050061), as applied to claims 211-213,217-223,225,233 above, and further of Nayfeh et al (6,585,947).

The references including Shiho, Jacobson, Kim, Komyoji teach a method for making a pattern of semiconductor film, as applied to claims 211-213,217-223,225,233 above, wherein Shiho also teaches employing the printed semiconductor nanoparticle film for forming electronic devices, and wherein Jacobson teaches printing a solution comprising passivated semiconductor nanoparticles (col 4, lines 47-67) having a capping passivation layer in order to form a pattern (col 5, lines 34-45, col 6, lines 1-10; col 4, lines 13-15; Fig 4, col 7, lines 10-20), wherein the nanoparticles may be passivated at the surface by an organic capping group which is largely determined the solubility of the nanoparticles including silicon (col 4, lines 48-64).

The references including Shiho and Jacobson already teach printing a solution comprising passivated semiconductor nanoparticles, while claim 214 recites the passivation layer comprising of, such as, hydrogen.

However, Nayfeh teaches a solution comprising passivated semiconductor nanoparticles, wherein the passivation layer comprises hydrogen (col 5, lines 3-12; col 3, lines 35 to col 6).

Therefore, the subject matter as a whole would have been obvious to one of ordinary skill in the art at the time the invention was made to print a solution having the passivated semiconductor nanoparticles for forming the patterned semiconductor film of the references including Jacobson and Shiho by employing the passivated semiconductor nanoparticles with the passivation layer comprising of high quality hydrogen coating, as taught by Nayfeh. This is at least because the high quality coating fully protects the semiconductor nanoparticles from uncontrollable low quality post interactions in the ambient atmosphere.

11. Claim 224 is rejected under 35 U.S.C. 103(a) as being unpatentable over Shiho (2003/0045632), Jacobson (6,294,401), Kim (6,355,198), Komyoji (2002/0050061), as applied to claims 211-213,217-223,225,233 above, and further of Tani et al (5,254,439).

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The references including Shiho, Jacobson, Kim, Komyoji teach a method for making a pattern of semiconductor film, as applied to claims 211-213, 217-223, 225, 233 above. Shiho also teaches (at paragraphs 127, 110-113). Shiho further teaches (at paragraph 110) printing and irradiating the composition with an ultraviolet light (paragraph 138), wherein when the coating film is to be treated with light to convert it into a silicon film, the desired pattern can also be formed by exposing part of the coating film selectively using a photomask having a desired pattern (paragraph 127).

The references including Shiho thus lack selectively irradiating the composition before curing.

However, Tani further teaches (at Figs 2,3; col 5, line 60 through col 6) selectively irradiating the layer through a mask aligned on substrate as marked, and removing a portion of the layer after irradiating in order to form a plurality of patterned layers.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to pattern the semiconductor film of the references including Shiho by selectively irradiating through a mask and removing a portion of the layer as taught by Tani before curing the semiconductor film of Shiho. This is because these patterning techniques are alternative and art recognized equivalent for substitution in forming distinct patterned semiconductor films on the substrate so as a plurality of semiconductor thin film transistors can be fabricated at the same time.

***Allowable Subject Matter***

12. Claims 41, 44, 46, 51, 53-54, 58-59, 61-65, 100-101, 103-119, 121-125, 128, 136-147, 149-150, 152, 155-165, 204, 206, 231, and 235 are allowed.

13. The following is a statement of reasons for the indication of allowable subject matter:

The Declaration under 37 C.F.R. 1.132 of Fabio Zurcher filed November 23, 2009, Applicant's Amendment, and the remarks thereof are found convincing, and have overcome the rejection of independent claim 41.

***Response to Amendment***

14. Regarding independent claim 41: The Declaration under 37 C.F.R. 1.132 of Fabio Zurcher filed November 23, 2009, Applicant's Amendment, and the remarks thereof are found convincing, and have overcome the rejection of independent claim 41. Claim 41 and its dependent claims are allowed as above.

15. Applicant's amendment, remarks, with the Declaration filed November 23, 2009 with respect to newly added independent claims 207 and 211, and their dependent claims, have been considered but they are found not persuasive, and are moot in view of the new ground(s) of rejection.

\*\* Regarding claim 207: Applicant remarked (at 11/23/2009 remark pages 36+) about the Zurcher Declaration that

“...[D]ata from experiments conducted to test the stability of Si<sub>5+</sub> cyclosilanes exhibit improved stability in some cycloalkanes (cyclohexane, cycloheptane and cis-decalin)...The improved stability of Si<sub>5+</sub> cyclosilanes in some cycloalkane solvents...was unexpected...”

In response, this is noted and found unconvincing. As applied above, Shiho, as a primary reference, clearly teaches using the first cyclic Group IVA compound of the formula Si<sub>n</sub>R<sub>m</sub>, n is an integer of 3 or more and m is integer of 2n+2, wherein Si<sub>n</sub>H<sub>2n+2</sub> (n is of 2 to 8), or Si<sub>i</sub>H<sub>2j</sub> (j is of 2 to 8) or Si<sub>k</sub>H<sub>k</sub> (k is 6,8, or 10) are mentioned at paragraphs 18,44, which formula of Shiho reads on the claimed formula of (AH<sub>x</sub>)<sub>n</sub>, with A is Si, n is 3 to 8, and x is 1 or 2, in which the first cyclic Group IVA compound of Shiho above also comprises Si<sub>5+</sub> cyclosilanes. Shiho also clearly teaches using the cycloalkane solvent (cyclohexane is one of cycloalkanes at paragraphs 0103,0102,153 of Shiho).

Thus, since Shiho anticipatively teaches the limitations as tested and declared, the Shiho compound in the same cyclohexane solvent does in fact possess the same particular benefits of stability, etc., as in the Zurcher Declaration. Even though the benefits (e.g. stability) is not recognized in the prior art, applicant's recognition of the benefit is not in itself sufficient to

distinguish the claimed compound from the prior art of Shiho. In re Dillon, 919, F.2d 688, 16 USPQ2d 1897 (Fed. Cir. 1991).

\*\* Regarding claim 211: Applicant remarked (at 11/23/2009 remark pages 42+) about the Zurcher Declaration, such that

“...the stability of Si<sub>5+</sub> cyclosilanes in some cycloalkane solvents...”,  
“alkyl-passivated silicon nanoparticles exhibit a solubility...”, and  
“...[I]f the cyclic Group IVA compound are not stable in the composition, they may precipitate prior to printing, or during a printing process, resulting other phenomena (e.g. clogged inkjet nozzles or uneven mass distribution...)”.

In response, this is noted and found unconvincing. Claim 211 does not include the limitations as recited in other claims 41 and 207. The evidence does not commensurate in scope with the claimed invention. In re Kulling, 897 F.2d 1147, 1149 14 USPQ2d 1056,1058 (Fed. Cir. 1990); In re Grasselli 713 F.2d 731, 743, 218 USPQ 769, 777 (Fed. Cir. 1983). Furthermore, discussion above to claim 207 is fully repeated herein and applied the same.

Moreover, given the strength of the prima facie obviousness for showing the obviousness of printing one or more lines having a width, length, thickness, and spacing as claimed, the evidence on the secondary consideration was inadequate to overcome a final conclusion of obviousness Newell Cos., Inc. v. Kenney Mfg. Co., 864 F.2d. 757, 768, 9 USPQ2d 1417, 1426 (Fed. Cir. 1988).

It is well settled that one can not show non-obviousness by attacking the references individually where, as here, the rejection is based on combinations of references. In re Young, 403 F.2d 754,159 USPQ 725 (CCPA 1968); In re Keller 642 F.2d 413, 208 USPQ 871 (CCPA 1981). Moreover, the rejection is not overcome by pointing out that one reference does not contain a particular limitation when reliance for that teaching is on another reference. In Re Lyons 150 USPQ 741 (CCPA 1966).

It would have been obvious because a person of ordinary skill in the art would have been motivated to combine the prior art to achieve the claimed invention and that there would have been a reasonable expectation of success when employing a composition solution in the ink jet

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printing method, and because “a person of ordinary skill has a good reason to pursue the known options within his or her technical grasp. If this lead to the anticipated success, it is likely the product not of innovation but of ordinary skill and common sense” for forming a plurality of semiconductor patterns on a substrate, and because ink jet printing method is a particular known technique was recognized as part of the ordinary capabilities. In re Supreme Court Decision in KSR International Co. v. Teleflex Inc. 82 USPQ2d, 1385 (2007).

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Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

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Any inquiry concerning this communication or earlier communications from the examiner should be directed to Michael M. Trinh whose telephone number is (571) 272-1847. The examiner can normally be reached on M-F: 9:00 Am to 5:30 Pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Zandra Smith can be reached on (571) 272-2429. The central fax phone number is (703) 872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Oacs-20

/Michael Trinh/  
Primary Examiner, Art Unit 2822